

# Technical Memorandum

**TO:** Mr. Robert Williams, Oregon Department of Environmental Quality  
**FROM:** Christine Kimmel, LHG, and Brett Borgeson  
**DATE:** August 18, 2016  
**RE:** **Work Plan**  
**Monitoring Well BOP-7(d) Installation**  
**Troutdale Gravel Aquifer Remedial Action**  
**Boeing Portland Facility**  
**Gresham, Oregon**  
**(ECSI #13)**

## Introduction

This work plan is submitted on behalf of The Boeing Company (Boeing) and provides procedures for installation of a groundwater monitoring well, BOP-7(d), to be located along the northwestern portion of the Troutdale Gravel Aquifer (TGA) remedy area. The proposed well would be part of the TGA remedy being conducted under Oregon State Department of Environmental Quality (ODEQ) Consent Order No. LQSR-NWR-04-012. Installation of well BOP-7(d) is proposed in the TGA Downgradient Corrective Action Area direct vicinity of existing well BOP-7(i) and former monitoring wells BOP-7(s), as shown on Figure 1. Existing well BOP-7(i) is screened in the siltstone layers of the confining unit between the TGA and the underlying Troutdale Sandstone Aquifer (TSA) and does not adequately represent TGA groundwater conditions. We propose the installation of well BOP-7(d) with a screen toward the base of the TGA to provide groundwater quality data along the northwestern portion of the remedy area.

Wells BOP-7(s) and BOP-7(i) were installed in 1987 in accordance with Oregon Water Resource Department (OWRD) regulations (Oregon Administrative Rules Chapter 690, Division 240). Well BOP-7(s) was installed as a shallow monitoring well and screened in a perched groundwater zone. Groundwater sample results collected at BOP-7(s) indicate site compounds of potential concern (COPCs) were consistently below the respective cleanup levels, as summarized in Table 1. Based on groundwater data, BOP-7(s) was decommissioned in 1993. A copy of the soil boring and well as-built information is provided in Attachment 1.

Monitoring well BOP-7(i) is screened in the low-permeable first siltstone unit (SU1a) of the four distinctive geologic subunits of siltstone and fine-grained sandstone, composing the confining layer between the TGA and the underlying TSA. Existing well BOP-7(i) is located between extraction wells E-12 (northwest of well) and E-2 (southeast of well); and between former monitoring well BOP-7(s) and TSA monitoring well BOP-22R(ds) as shown on Figure 1. Concentrations of volatile organic compounds (VOCs) have declined to below the respective site cleanup levels at most TGA wells in the Downgradient Corrective Action Area; however, trichloroethene (TCE) concentrations have persisted at well BOP-7(i) since installation in 1987. In May 2016, the TCE concentration at BOP-7(i) was

250 micrograms per liter ( $\mu\text{g/L}$ ), which is significantly lower from the historical maximum concentration of 1,500  $\mu\text{g/L}$  (June 1990); however, concentrations remain above the cleanup level (5  $\mu\text{g/L}$ ), as summarized in Table 1.

The planned location for monitoring well BOP-7(d) will be approximately 15 feet (ft) east of BOP-7(i). A cross section illustrating the screened interval of the purposed monitoring well BOP-7(d), along with nearby TGA wells, is presented on Figure 2. The scope of work described in this work plan includes: drilling and borehole soil sampling, well installation and development, and well sampling and testing.

## Well Drilling and Borehole Soil Sampling

Monitoring well BOP-7(d) will be drilled and installed using the procedures described in the following sections and in accordance with applicable OWRD regulations using roto-sonic drill methods. Well installation will be performed by an Oregon licensed driller and overseen by a registered geologist. The description of the completed field activities and the prepared exploration log will be included in the annual TGA remedy report.

Geologic sampling and logging will be performed continuously during the drilling of BOP-7(d). Grab soil samples will be collected from the core barrel, screened for organic vapors using a photo-ionization detector (PID) and any visual signs of contamination (e.g., soil staining or sheen), and will be described consistent with American Society of Testing and Materials procedures and recorded on a field boring log with other relevant drilling information. A detailed log will be maintained showing sampling depths, sampling method, soil types, stratification, groundwater conditions, and other pertinent information. The log will also contain the names of the drilling company and drillers, the type of drill rig, start and finish dates for drilling, borehole diameter, boring number, and boring location. Downhole drilling and sampling equipment will be decontaminated using a high-pressure, hot-water steam-cleaner before and after drilling of the well.

Drilling will be conducted using an 8-inch-diameter temporary steel casing to the top of SU1, at which the drilling operations will cease. Based on geologic information from wells located within the vicinity and ground surface topographic information, the top of the SU1 is anticipated to be approximately 156 ft below ground surface (bgs).

## Well Installation and Development

All well casing material will be steam-cleaned before installation in the boring if factory decontamination procedures cannot be determined. Well installation procedures are provided below:

- Well Casing and Screen Installation: BOP-7(d) will be installed with 2-inch-diameter, threaded Schedule 80 PVC casing, and a 10-ft long well screen with a slot size of 0.020. The screen interval will be installed toward the base of the TGA at approximately 145 to 155 ft bgs. Centralizers will be installed above and below the screen and near the top of the well casing.

Once the well casing and screen are installed, the total length of the well will be verified and documented by lowering a weighted tape to the bottom of the well.

- **Filter Pack Installation:** The annular well space between the boring walls and well screen will be packed with commercially prepared, pre-sized, and pre-washed No. 8-12 Colorado silica sand (or equivalent) to approximately 3 ft above the top of well screen. The filter pack will be cleaned and pre-sized so that approximately 96 to 100 percent of the sand passes the US Standard No. 8 sieve and is retained on the US Standard No. 12 sieve. The filter pack will be installed through a tremie pipe positioned between the well casing and the temporary drill casing as the drill casing is slowly withdrawn. To ensure complete settlement of the filter pack material, the well will be surged with a surge block when the filter pack is placed. The top depth of the filter pack material will be verified with a weighted tape.
- **Annular Bentonite Seal:** A 5-ft interval of bentonite chip or pellet will be used as a seal above the filter pack. The annular space from the bentonite seal to the surface will be filled with a high bentonite percentage grout having a minimum density of 9.5 lbs/gallon. Through the saturated zone, the bentonite grout will be installed through a tremie pipe between the well casing and the temporary drill casing as the temporary casing is slowly withdrawn. The tremie pipe will have side discharges to help prevent grout from disturbing the bentonite seal and filter pack. Grout densities will be field verified and recorded on the exploration log using a mud balance.
- **Protective Monument:** A lockable, flush-grade security monument will be set in concrete and installed around the well to protect it from unauthorized entry or damage. A minimum of a 2-ft by 2-ft by 4-inch thick concrete surface seal will be installed around the flush-mount monument protective casing.

## Well Development

Monitoring well BOP-7(d) will be developed by surging and pumping, or other suitable methods, after the grout has set in the well annulus for a minimum of 24 hours. Development will remove soil introduced during installation activities and establish hydraulic continuity between the filter pack and the soil formation. Development will continue until at least five well volumes of water are removed, soil is reasonably cleared from the wells, and the turbidity of the water is low. Groundwater field parameters (pH, temperature, conductivity, and turbidity) will be measured and recorded during well development. Groundwater sampling activities will be conducted after the well has fully restabilized after development (about 2 to 3 days).

## Topographic Survey

A vertical and horizontal survey will be conducted by a licensed land surveyor to document the location of the well and to establish a reference point elevation for groundwater level measurements. The same datum used in previous site investigations will be used and the work will be consistent with the regional surveys conducted by Chase Jones and Associates. The ground elevation will be reported to the nearest 0.01 ft and the top of the PVC well casing will be reported to the nearest 0.001 ft.

## WELL SAMPLING AND TESTING

Well BOP-7(d) will be added to the TGA Groundwater Monitoring Program. Groundwater elevation will be monitored at BOP-7(d) using a manual water level indicator on a quarterly basis and upon the planned start of any sample collection.

Groundwater samples will be collected on a quarterly basis and analyzed for VOCs using diffusion bag samplers (DBS) as other TGA wells in the remedy network. Groundwater analytical results will be included in the annual reporting requirements for the existing remedial action.

## Management of Investigation-Derived Waste

Investigation-derived waste (IDW) during well drilling activities, soil cuttings, and water will be separated in Oregon Department of Transportation (ODOT)-approved 55-gallon drums or a suitable soil box. Solid residuals (e.g., Tyvek gloves, etc.) will be contained in 55-gallon drums or other covered containers, and identified with the date of collection, origin (i.e., location and depth), and a brief description of the contents. Containerized waste will be transferred to a designated storage area on the Boeing facility and stored until characterized and classified. Per previous discussions with ODEQ, the IDW from the wells will be field-screened for the possible presence of contamination using visual signs of soil staining or sheen, and vapor head-space measurements with a portable PID meter. One composite sample from each IDW storage container will be collected and analyzed for the disposal facility requested analyte suite. If field screening results and/or analytical results indicate the presence of contamination, ODEQ will be consulted for a "No Longer Contains" determination. Upon receipt of the No Longer Contains determination (if needed), the IDW will be transported offsite for disposal by Boeing's waste management system, consistent with applicable state and federal regulations.

Water generated from well drilling, installation, and development will be routed to the onsite Groundwater Treatment System (GWTS) for treatment prior to discharge to Storm Drain Creek.

LANDAU ASSOCIATES, INC.



Brett Borgeson  
Project Scientist



Christine B. Kimmel, LG  
Associate Geologist

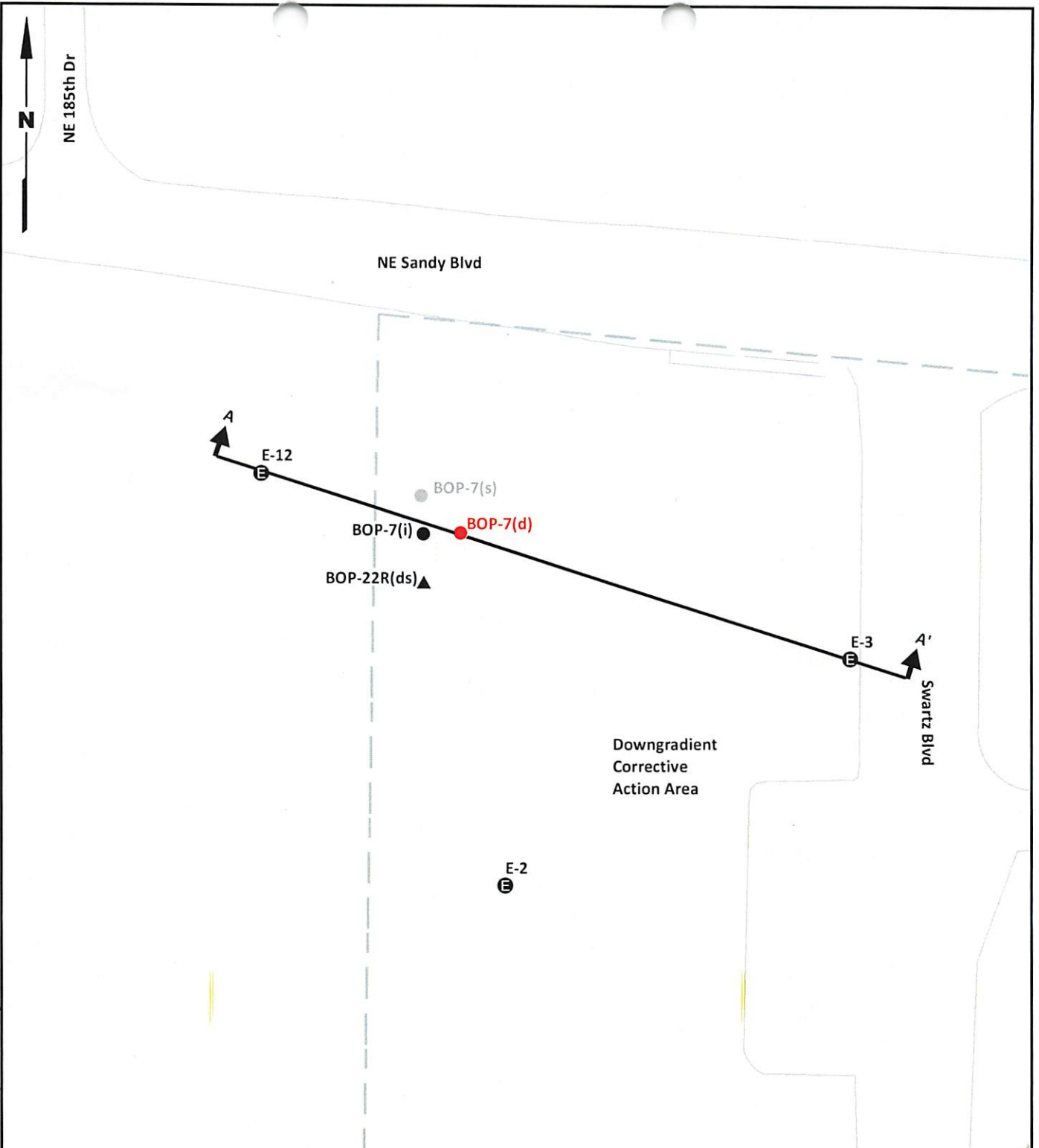
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**Attachments:**

Figure 1	Proposed Monitoring Well Location
Figure 2	Hydrogeologic Section A-A'
Table 1	Historic COPC Data BOP(7s,i)
Attachment 1	BOP-7(s,i) Exploration Logs

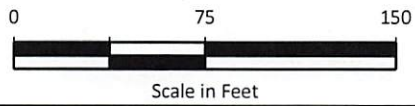
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**Legend**

- E TGA Extraction Well
- TGA Monitoring Well
- Decommissioned TGA Monitoring Well
- ▲ TSA Monitoring Well
- Proposed Monitoring Well Location

--- Boeing Property Line



**Note**

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

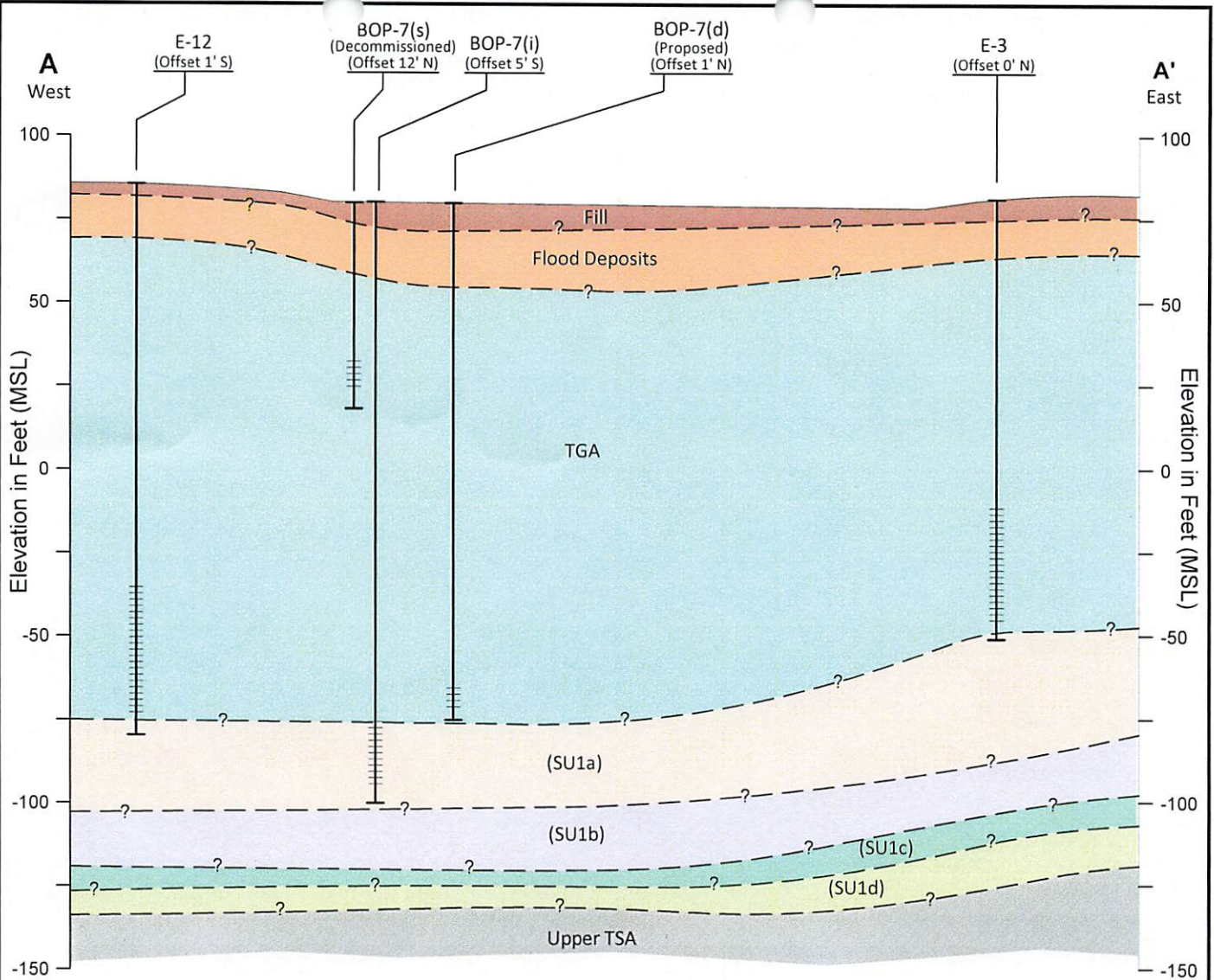


Boeing Portland  
Gresham, Oregon

**Proposed Monitoring  
Well Location**

Figure  
**1**

LANDAU ASSOCIATES, INC. | G:\Projects\025\116\116\110\Source Area Investigation\F02 CrossSection.dwg (A) Figure 2" 8/2/2016



**Legend**

- BOP-7(i) — Project Exploration Designation
- (Offset 5' S) — Offset Distance in Feet and Direction
- Top of Exploration
- Inferred Geologic Contact
- Well Screen Interval
- Bottom of Exploration

- Troutdale Gravel Aquifer (TGA)
- Flood Plain Desposits
- Subunit A (SU1a)
- Subunit B (SU1b and CU1)
- Subunit C (SU1c)
- Subunit D (SU1d)
- Siltstone Layer (SU1)
- Troutdale Sandstone Aquifer (Upper TSA)

**Notes**

1. This cross section approximates conditions between data collection points.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



**TABLE 1  
HISTORICAL COPC DATA  
WELLS BOP-7(s,i)  
BOEING PORTLAND**

Location	Date Collected	1,1,1,-TCA	1,1-DCE	cis-1,2-DCE	PCE	TCE	VC
	Cleanup Standards	200	7	70	5	5	2
BOP-7(i)	3/25/1987	890	38	--	31	860	--
BOP-7(i)	5/19/1987	1200	11 J	--	26	896	--
BOP-7(i)	5/20/1987	1910	13 J	--	24 J	931	--
BOP-7(i)	5/21/1987	1210	8 J	--	17 J	852	--
BOP-7(i)	5/22/1987	1260	6 J	--	15 J	837	--
BOP-7(i)	10/20/1987	1800	47	--	38	890	--
BOP-7(i)	12/3/1987	2100	55	--	40	960	--
BOP-7(i)	7/19/1988	2200	86	--	38	600	--
BOP-7(i)	2/1/1989	1500	95	--	37	680	--
BOP-7(i)	5/19/1989	560	69	--	44	1200	--
BOP-7(i)	8/8/1989	510	78	--	54	840	--
BOP-7(i)	11/13/1989	610	73	130	39	1000	--
BOP-7(i)	2/6/1990	880	81	100	41	1000	--
BOP-7(i)	6/7/1990	750	130	--	42	1500	--
BOP-7(i)	11/5/1990	540	120	110	44	1200	3 U
BOP-7(i)	2/5/1991	530	130	130	48	1400	75 U
BOP-7(i)	2/6/1991	530	130	130	44	1400	75 U
BOP-7(i)	5/14/1991	360	100	100	42	980	2 U
BOP-7(i)	5/15/1991	350	89	95	40	960	10 U
BOP-7(i)	2/11/1993	190	68	72	40	1300	2 U
BOP-7(i)	2/11/1993	180	71	70	35	1200	40 U
BOP-7(i)	5/10/1993	150	63	61	30	1000	2 U
BOP-7(i)	11/29/1993	120	44	48	30	890	2 U
BOP-7(i)	2/14/1994	100	52	51	29	730	2 U
BOP-7(i)	5/31/1994	100	49	47	31	760	2 U
BOP-7(i)	7/30/1994	60 J	33 J	35 J	20 J	720 J	20 U
BOP-7(i)	7/30/1994	83 J	46 J	44 J	28 J	920 J	0.2 U J
BOP-7(i)	10/24/1994	1 U	1 U	1 U	1 U	14	2 U
BOP-7(i)	2/20/1995	61	41	44	28	440	2 U
BOP-7(i)	2/20/1995	60	40	44	27	500	2 U
BOP-7(i)	5/30/1995	55	32	31	20	740	10 U
BOP-7(i)	8/22/1995	64	39	37	23	760	10 U
BOP-7(i)	11/10/1995	56	35	34	19	680	2 U
BOP-7(i)	11/10/1995	58	36	34	20	670	2 U
BOP-7(i)	2/21/1996	46	29	30	17	670	10 U
BOP-7(i)	5/29/1996	37 J	24 J	25	17	610	10 U
BOP-7(i)	5/29/1996	49 J	33 J	30	21	580	2 U
BOP-7(i)	8/7/1996	35 J	25	24	16 J	580	10 U
BOP-7(i)	8/7/1996	45 J	34	29	20 J	670	2 U
BOP-7(i)	11/18/1996	41	35	33	17	710	10 U
BOP-7(i)	2/20/1997	33	25	27	16	610	10 U
BOP-7(i)	5/27/1997	29	25	26	13	510	10 U
BOP-7(i)	8/12/1997	35	30	29	18	610	2 U
BOP-7(i)	2/25/1998	36	30	29	19	620	2 U
BOP-7(i)	8/24/1998	35	38	33	21	840	2 U
BOP-7(i)	2/15/1999	27	30	26	16	660	2 U
BOP-7(i)	8/19/1999	19	21	23	13	450	1 U
BOP-7(i)	2/8/2000	18	22	22	12	440	1 U
BOP-7(i)	8/27/2000	16	14	18	11	320	1 U
BOP-7(i)	2/16/2001	16 J	19 J	18 J	11 J	400 J	1 U J
BOP-7(i)	8/13/2001	12	16	16	8	330	5 U
BOP-7(i)	2/27/2002	10	11	12	6.9	280	3 U
BOP-7(i)	8/9/2002	7.5	10	8	5.3	210	3 U

**TABLE 1  
HISTORICAL COPC DATA  
WELLS BOP-7(s,i)  
BOEING PORTLAND**

Location	Date Collected	1,1,1,-TCA	1,1-DCE	cis-1,2-DCE	PCE	TCE	VC
	Cleanup Standards	200	7	70	5	5	2
BOP-7(i)	2/11/2003	8.1	10	9.4	6.6	180	1 U
BOP-7(i)	8/7/2003	7.7	9.6	9.2	6.9	210	1 U
BOP-7(i)	2/17/2004	5.8	12	9.8	6.4	210	1 U
BOP-7(i)	8/6/2004	6.3	12	10	5.8 U	230	2 U
BOP-7(i)	2/7/2005	5 U	8	8.6	5.6	210	5 U
BOP-7(i)	8/4/2005	4.6	8.4	7.9	5.1	160	1 U
BOP-7(i)	2/10/2006	4.7	8.4	6.6	4.7	160	1 U
BOP-7(i)	8/15/2006	2.9	5.7	5.8	3.1	140	1 U
BOP-7(i)	2/8/2007	3.1	5.9	5.6	3.5	110	1 U
BOP-7(i)	8/7/2007	2.7	6	5.2	3.2	120	1 U
BOP-7(i)	2/20/2008	2.5	6.8	5.2	3.2	100	1 U
BOP-7(i)	8/12/2008	1.8	5	3.7	2.4	82	1 U
BOP-7(i)	11/11/2008	1.8	4.8	3	2.3	68	0.2 U
BOP-7(i)	11/11/2008	1.9	4.9	2.9	2.2	67	0.5 U
BOP-7(i)	11/11/2008	1.3	3.1	1.8	1.6	42	0.5 U
BOP-7(i)	11/11/2008	1.3	3.2	1.9	1.7	44	0.5 U
BOP-7(i)	11/11/2008	1.6	4.3	2.4	2	60	0.5 U
BOP-7(i)	2/12/2009	2.8	8.1	6 J	3.6	160	1 U
BOP-7(i)	2/12/2009	3.1	8.8	7.4 J	3.6	150	1 U
BOP-7(i)	5/21/2009	2.6	9.6	6.1	3.9	170	1 U
BOP-7(i)	8/26/2009	2.8 J	9.5	24	4.5	130	0.2 U
BOP-7(i)	11/12/2009	3 U	6.6	12	3.4	130	3 U
BOP-7(i)	2/5/2010	1.6	5.6	7.7	2.7	90	0.6 U
BOP-7(i)	5/6/2010	3 U	11	8	4	220	3 U
BOP-7(i)	5/26/2010	1.6	6.6	4.8	3.2	120	1 U
BOP-7(i)	8/17/2010	1.5	6.3	4.2	2.9	110	1 U
BOP-7(i)	8/17/2010	1.6	6.5	4.4	2.9	100	1 U
BOP-7(i)	11/17/2010	3 U	4.7	3.4	3 U	87	3 U
BOP-7(i)	11/17/2010	3 U	4.5	3.2	3 U	86	3 U
BOP-7(i)	2/14/2011	1.4	6.2	3.3	3.2	100	1 U
BOP-7(i)	2/14/2011	1.5	6.5	3.4	3.2	100	1 U
BOP-7(i)	5/4/2011	1.1	4.5	3.3	2.6	91	1 U
BOP-7(i)	5/4/2011	1 U	4.1	3	2.4	81	1 U
BOP-7(i)	8/8/2011	1.2	5.2	3.3	2.6	85	1 U
BOP-7(i)	8/8/2011	1.2	5.2	3.4	2.5	86	1 U
BOP-7(i)	11/2/2011	1.4	5.6 J	3.5	2.5	98	1 U
BOP-7(i)	11/2/2011	1.5	7.2 J	4.5	2.8	110	1 U
BOP-7(i)	2/7/2012	1.3	5.2	3.3	2.4	86	1 U
BOP-7(i)	2/7/2012	1.3	5.6	3.4	2.4	86	1 U
BOP-7(i)	5/3/2012	1.5	6.2	3.7	2.2	84	1 U
BOP-7(i)	5/3/2012	1.6	6.7	4	2.3	87	1 U
BOP-7(i)	8/7/2012	1.5	6.1	4.1	2.7	110	1 U
BOP-7(i)	8/7/2012	1.4	5.9	3.8	2.7	110	1 U
BOP-7(i)	11/9/2012	3.1	20	12	3.1	270	1 U
BOP-7(i)	11/9/2012	2.9	18	11	2.6	310	1 U
BOP-7(i)	2/5/2013	3.4	21 J	12	5.3	300	0.4 U
BOP-7(i)	2/5/2013	3.6	17 J	13	5.5	310	0.4 U
BOP-7(i)	5/6/2013	3.7	16	12	5.5	330	1 U
BOP-7(i)	5/6/2013	4	14	12	5.3	350	1 U
BOP-7(i)	8/19/2013	4	19 J	13 J	4.9	300	1 U
BOP-7(i)	8/19/2013	4.5	24 J	16 J	5.6	310	0.2 U
BOP-7(i)	11/11/2013	4	18	12	5.4	220	0.2 U
BOP-7(i)	11/11/2013	4	17	12	5.2	210	0.2 U

**TABLE 1  
HISTORICAL COPC DATA  
WELLS BOP-7(s,i)  
BOEING PORTLAND**

Location	Date Collected	1,1,1,-TCA	1,1-DCE	cis-1,2-DCE	PCE	TCE	VC
	Cleanup Standards	200	7	70	5	5	2
BOP-7(i)	2/21/2014	2.6 J	12 J	9.7	4.5 J	<b>180</b>	0.4 U
BOP-7(i)	2/21/2014	3.7 J	15 J	10	5.8 J	<b>200</b>	0.2 U
BOP-7(i)	5/7/2014	2.7	12 J	9	3.7	<b>180</b>	1 U
BOP-7(i)	5/7/2014	3.3	15 J	11	4.5	<b>160</b>	0.2 U
BOP-7(i)	8/14/2014	3	<b>13</b>	9.6	4.4	<b>190</b>	1 U
BOP-7(i)	8/14/2014	3.4	<b>15</b>	10	<b>5.2</b>	<b>160</b>	0.2 U
BOP-7(i)	11/7/2014	2.8 J	17 J	15	3.9 J	<b>250</b>	1 U
BOP-7(i)	11/7/2014	3.6 J	22 J	18	6.8 J	<b>240</b>	0.2 U
BOP-7(i)	2/9/2015	3.5	<b>23</b>	17	<b>6.5</b>	<b>400</b>	1 U
BOP-7(i)	2/9/2015	3.3	<b>20</b>	17	<b>5.8</b>	<b>360</b>	1 U
BOP-7(i)	5/8/2015	1.8	<b>7.3</b>	54	0.5	<b>73</b>	0.2 U
BOP-7(i)	5/8/2015	2	<b>8.9</b>	52	0.6	<b>61</b>	0.2 U
BOP-7(i)	8/11/2015	1 U	4.3	12	1.1	<b>50</b>	0.4 U
BOP-7(i)	8/11/2015	0.9	4.9	12	1.2	<b>60</b>	0.3
BOP-7(i)	11/5/2015	8.8 J	17 J	17 J	4.7 J	310 J	2 U
BOP-7(i)	11/5/2015	3.5 J	23 J	21 J	5.8 J	250 J	0.2 U
BOP-7(i)	2/4/2016	5 U	<b>19</b>	20	<b>5</b>	<b>350</b>	2 U
BOP-7(i)	2/4/2016	3.4	<b>22</b>	22	<b>5.6</b>	<b>350</b>	1 U
BOP-7(i)	5/4/2016	5 U	17 J	21	5.5 J	<b>250</b>	2 U
BOP-7(i)	5/4/2016	3.6	23 J	25	7.1 J	<b>250</b>	0.3
BOP-7(s)	3/25/1987	--	--	--	--	0.4	--
BOP-7(s)	12/31/1987	1	--	--	0.2	2.9	--
BOP-7(s)	8/7/1989	--	--	--	--	0.3	--
BOP-7(s)	2/7/1991	1 U	1 U	1 U	1 U	1 U	2 U
BOP-7(s)	8/8/1991	1 U	1 U	1 U	1 U	1 U	2 U
BOP-7(s)	1/21/1992	1 U	1 U	1 U	1 U	0.7	2 U
BOP-7(s)	7/14/1992	1 U	1 U	1 U	1 U	1 U	2 U

Well Decommissioned in January 1993

µg/L = micrograms per liter

TCE = trichloroethene

PCE = tetrachloroethene

1,1-DCE = 1,1-dichloroethene

cis-1,2-DCE = cis-1,2-dichloroethene

1,1,1-TCA = 1,1,1-trichloroethane

NA = Not Analyzed

Note: All units in µg/L

U = Indicates the compound was

undetected at the reported concentration.

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

M = Estimated value of analyte found and confirmed by analyst, but with low spectral match.

Bold = Detected Compounds

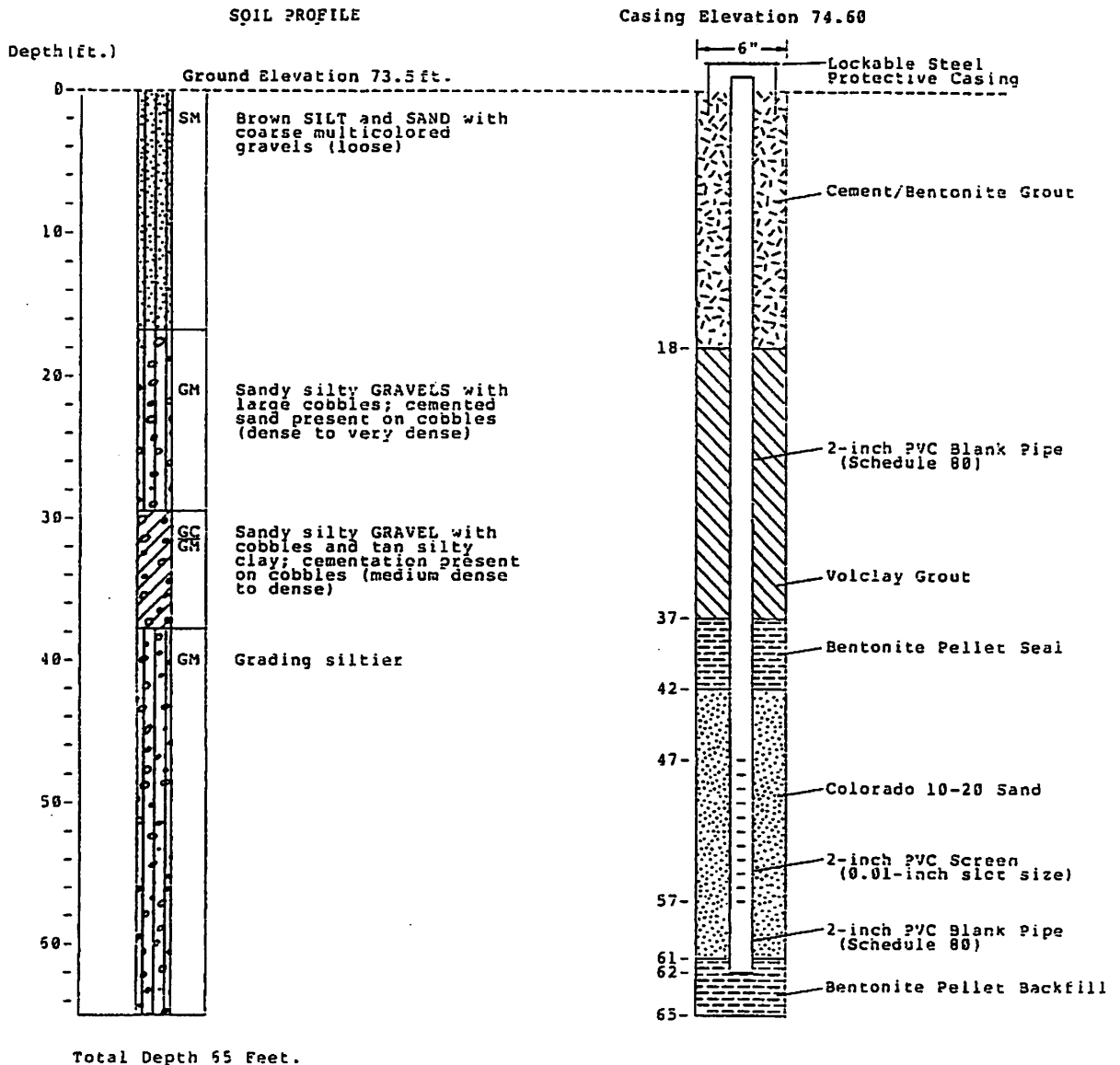
Boxed = Exceeds Cleanup Standard

ATTACHMENT 1

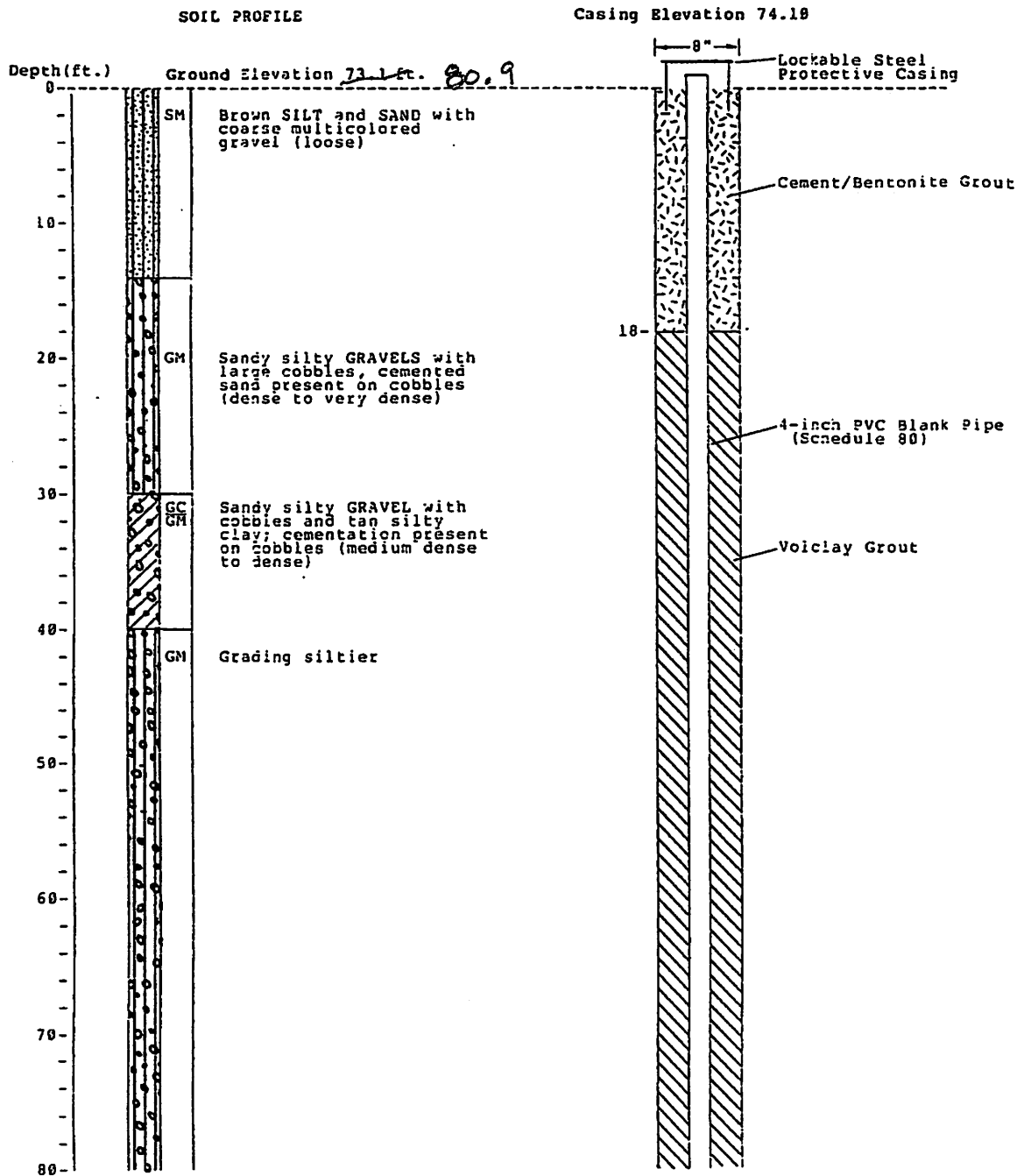
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## **BOP-7(s,i) Exploration Logs**

WELL BOP-7(s)



WELL BOP-7(i)



Continued next page

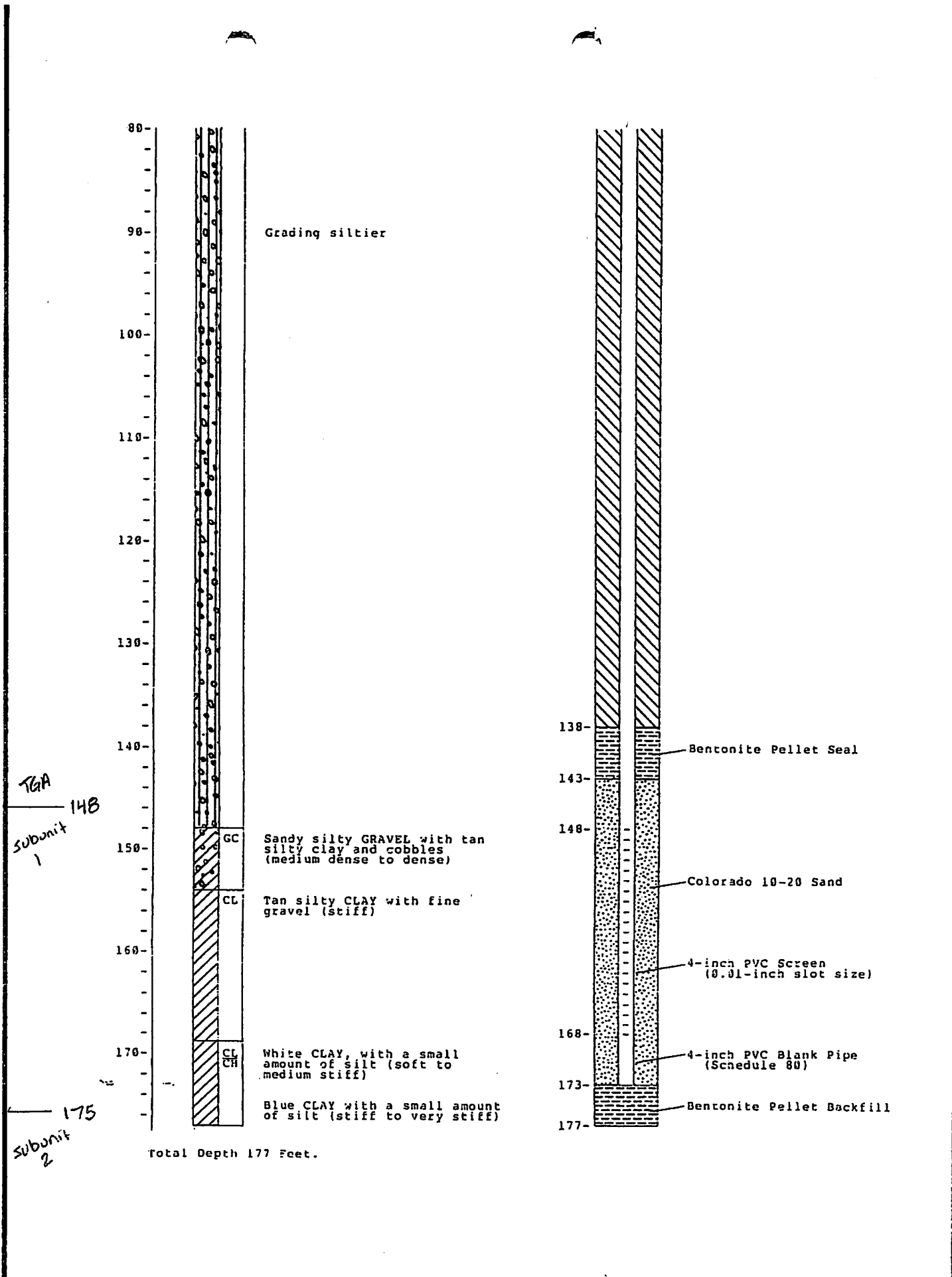


Figure B-2